DOCUMENT RESUME

ED 070 289 EM 010 582

AUTHOR	Koch, Warren J.
TITLE	The Use of Computers in Instruction in Secondary Schools.
INSTITUTION	National Association of Secondary School Principals, Washington, D.C.
PUB DATE	72
NOTE	47p.
AVAILABLE FROM	The National Association of Secondary School Principals, 1201 16th Street, N.W., Washington, D.C. 20036 ($1.50)
EDRS PRICE	MF-$0.65 HC Not Available from EDRS.
DESCRIPTORS	*Computer Assisted Instruction; *Computer Oriented Programs; Computers; Educational Improvement; *Educational Technology; Guides; *Instructional Technology; *Secondary Education

ABSTRACT

This booklet provides the initial information necessary for school administrators who are considering the introduction or expansion of computer instruction in their school. The booklet contains a variety of non-technical information pertaining to the use of computers in instruction. It summarizes the hardware and software availability as well as the personnel requirements necessary for on-school staffing. Several examples of regional consortiums and on-going projects are listed and discussed. The names and addresses of personnel concerned with these projects are of particular utility. An example of an instructional guide is presented along with a glossary of terms used in computer technology. (MC)

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The Use of Computers in Instruction in Secondary Schools

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The Use of Computers in Instruction in Secondary Schools

by Warren J. Koch

NATIONAL ASSOCIATION OF SECONDARY SCHOOL PRINCIPALS
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The National Association of Secondary School Principals
1201 16th St., N.W., Washington, D.C. 20036
Library of Congress Catalog Card Number: 72-94615
ISBN Number: 0-88210-043-2

$1.50 per copy. Twenty percent discount for 10 or more copies. Special rates for 25 or more copies available upon request. Payment must accompany orders of $5 or less.

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Foreword

In the continuing search for ways to improve the educational opportunities available to students, an increasing number of educators are finding that the computer is a powerful ally. To date relatively few schools have gone beyond the experimental stage in tapping the resources but some exceedingly promising teacher-student developed applications are starting to emerge. Thus, there is now available school-based data and annotated information that can be useful to administrators and teachers who are considering the future use of this instructional aid in their schools.

The suggestions which follow are limited to the instructional use of computers and are offered to the present user as well as those contemplating the use of this modern tool. Present users may wish to compare their school's program with what others are doing. Future users might wish to gain from the experiences that have already been obtained in using computers in the instructional process.

We are grateful to Warren Koch for undertaking this study which was sponsored by the Association's Committee on Educational Technology under the chairmanship of Wesley W. Walton. It is published with the expectation that these suggestions and examples will provide encouragement for others who are studying means by which they can improve educational programs for their students.

Owen B. Kiernan
Executive Secretary

Introduction

The Use of Computers in Instruction in Secondary Schools was written expressly for the information of school administrators. Since the development of instruction in schools is often directly related to the understanding and support of administrators, there is a need for basic but comprehensive information about computers written for the educator rather than for the technician.

Previous knowledge or understanding of computers is not necessary for full comprehension of the topics discussed. It is hoped that this booklet will provide the initial information necessary for school administrators who are considering the introduction or expansion of computer instruction in their schools.

The information contained in this publication is based on the research obtained during a year's sabbatical study by the author. This research project, endorsed by the National Association of Secondary School Principals and its Committee on Educational Technology was conducted in 1971. Through the cooperation of committee chairman Wesley W. Walton and the state representatives of NASSP's National Advisory Board on Educational Technology, a list of schools using computers in instruction was drawn up. These schools, located throughout the nation, were contacted to determine the extent of their programs. Of the 454 schools that were contacted, 334 or 74 percent replied. Following the survey, schools indicating unique or unusual programs involving the use of computers in instruction were visited to secure additional details of their operation. This phase of the research took the author to 33 schools located in 13 states.

USING THE COMPUTER FOR PROBLEM SOLVING. Students examine output from their program on the teletype terminal. Photo courtesy Digital Equipment Corp.

Basic Facts About Using the Computer

HOW COMPUTERS CAN BE USED IN INSTRUCTION

1. *Teaching computer skills.* This covers a wide area, starting from the simplest steps to the most complex programing techniques. A course in computer skills is where many schools begin their program of computer instruction. Instructional topics generally range from how a computer functions to simple computer programing using an easily learned computer language.

2. *Using the computer for problem solving.* Following as an extension of teaching computer skills, or even as a starting point itself, this approach to computer instruction teaches how a com-

puter can be used frequently as a problem-solving tool in mathematics and sometimes in chemistry and physics. One offshoot of this application is that the student in programing his problem for the computer usually gains a deeper understanding of the subject.

3. *Using the computer for modeling and simulation.* Although not as frequently found in practice as the previously mentioned uses of the computer, modeling and simulation applications in secondary schools are increasing because of the experimental projects being conducted. Economics, biology, chemistry, and physics are subjects that readily lend themselves to this use of the computer.

4. *Tutorial uses of the computer.* Also known as computer assisted instruction (CAI), this use usually requires sophisticated hardware and more computer memory than the previously mentioned instructional applications. Software is less available and more difficult to prepare locally. Commercial software packages are available in arithmetic and basic language arts skills. Although geared for elementary level pupils, these packages can be useful for remedial work on the secondary level. CAI is useful for drill and practice routines, for the computer is a patient tutor. Foreign languages and biology are subjects that schools have programed for drill and practice exercises successfully.

5. *Instructional diagnosis by means of the computer.* Also known as computer managed instruction (CMI), this use frees the teacher of many of the paperwork routines of individualized instruction. It is used most frequently in conjunction with programed methods of instruction. In CMI the computer tests and keeps a record of each student's progress in a particular curriculum area. It sometimes advises the student and/or teacher whether the student is ready for the next unit of instruction. It can also indicate where the student might need additional

remedial work by pointing out his weaknesses. Some computer programs also provide the remedial drill and practice needed by the student.

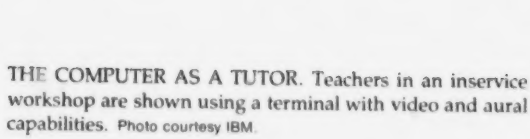
6. *Computer orientation for all students.* Some schools feel that all students, regardless of their goals, should receive some orientation in regard to computers. Such orientation ranges from one- to 10-period introductions to what computers are, what they can do, and what they cannot do. After this orientation, if interested, students are encouraged to use programed materials or to attend after-school sessions to learn how to program computers and eventually use them for problem solving in the courses that they are taking in high school. These schools do not offer formal courses during the school day in computer skills.

7. *Vocational and technical training.* Vocational and technical high schools that have access to computers are now going beyond the usual data processing courses that involve unit record hardware. In addition to teaching key punch, wiring, and machine operation, they have advanced to coding as well as to writing original computer programs. Some technical high schools now are offering three-year sequences in computer technology.

COMPUTER HARDWARE FOR THE SCHOOL

1. *Low cost or free computer services.* Low cost or even free computer services are often available to schools just for the asking. Sources that schools should investigate include the computer centers located in their own school districts' central offices, in nearby universities, or in local government, industry, and business offices.

2. *Consortium computer services.* Many schools have consortium computer services available to them. These consortiums



THE COMPUTER AS A TUTOR. Teachers in an inservice workshop are shown using a terminal with video and aural capabilities. Photo courtesy IBM.

are usually operated by universities, boards of cooperative services, or individual schools. In addition to providing low cost computer services, the consortium usually provides professional advice and guidance to schools using their services.

3. *Commercial Service Companies.* These companies provide services similar to regional consortiums, but because of their profit-making nature their fees are somewhat higher. The larger service companies frequently have ready-made software materials available for their customers.

4. *Buying or leasing a computer.* Owning a computer has advantages but it also puts responsibilities on the individual school. Before a school buys or leases a computer, it is advisable that the school have experienced personnel capable of operating and directing the program and the insurance of a good maintenance contract for the hardware. With the advent of mini-computers, costing less than $10,000 to purchase, many schools have been attracted to purchasing their own computer. One advantage of some of these mini-computers is that they can be added to, and thus become more sophisticated pieces of equipment as the school's computer program grows. There are also schools with experienced staff that have purchased or leased very powerful computer systems and have lowered their costs by selling computer time to neighboring schools.

5. *Batch Processing.* This is the most inexpensive way of conducting a program of computer instruction. In batch processing students use mark-sense or key punch cards to put their data into the computer. The computer can be located in the

school, the district's central office, a local business office, or a commercial service company. Output from the computer takes a few minutes, an hour, a day, or a week, depending on the location of the computer and the service available. Some educators feel that an immediate response from the computer is not essential and that batch processing programs can work. Other educators feel that the delay, especially if it is a long one, dulls the interest of students. But there is no denying the fact that batch processing is the least costly type of computer instruction program.

6. *Time-Sharing.* Time-sharing is fast becoming the most popular means of using computers in instruction. In time-sharing, a teletype machine (similar to a large electric typewriter) is located in the school and is connected by telephone line to the computer, which may be in another building in the school district, in a nearby town, or even in another state. In some time-sharing systems the teletype is replaced by a video screen with a typewriter keyboard that provides input to the computer. The input and output of the computer appears on the video screen. The teletype has the advantage of providing paper copy that can be saved. On the other hand, the video operation is noiseless. Time-sharing provides "hands on" experience with the computer at a cost lower than computer ownership. It has brought computer availability within the economic reach of schools and its cost is decreasing. One terminal can serve as a good beginning basis for a school's program.

PERSONNEL REQUIREMENTS

1. *Minimum requirements.* A program of computer instruction can be started with a minimum of one trained staff member.

The staff should be increased to at least two as soon as possible in order to provide a support person. Some programs have "died" when the trained staff member left the school and no one was available as a replacement. Also, a program shows more potential for growth as the number of trained staff increases.

2. *Staff Training.* Staff can be trained, especially for the batch processing and time-sharing systems, in as little as three to six weeks, depending on the intensity of the instruction. Other systems require longer periods of training. When a school purchases computer services or hardware, staff training is usually available through the supplier. Also, more and more colleges are offering courses for teachers in computer instruction. Many schools, once they have qualified personnel, run their own workshops for their staff.

A one semester course (or equivalent in time) in computer programing can qualify a teacher for conducting a course in Computer Programing, Computer Mathematics, or a related course involving the use of a computer terminal.

If the additional responsibility of running a computer or a computer system is added, the teacher will need more training in the operation of the computer. However, as mentioned, computer manufacturers frequently offer training of this type at their factory schools when schools purchase their equipment.

SOFTWARE AVAILABILITY

Software is now readily available for teaching computer skills and problem solving. Much of this has been published in the last few years. Software for modeling and simulation is more limited. CAI software that is available is often not readily

adaptable from one system to another. The major breakthrough in CAI software has been in the areas of arithmetic and language arts skills. These programs in their present state, however, cannot be run on all computers. Computer manufacturers have a limited amount of software that they provide their customers. Further discussion on software begins on page 29.

Some textbook publishers have made a start toward providing software for instruction by computers. This in all likelihood will be expanded. Some very effective software is developed within schools by teachers and students. They are usually quite willing to share these materials with other schools.

PROGRAMING LANGUAGES

What computer programing language a school will use will be dictated by the type of computer to which it has access. A school should determine this first before finalizing arrangements for computer services. This is an important factor insofar as instructional needs are best met by a programing language that is educational-user oriented. This is not true of all programing languages. Some of the more common languages useful to schools are: BASIC, FOCAL, and APL, which are easily learned; FORTRAN, which is useful for mathematics and science applications; and COBOL, which is geared for business uses.

USER GROUPS

Computer user groups are being organized in many areas of the country. Some are sponsored by computer manufacturers, others are local interest groups, while still others are

national in scope. It would be worthwhile for schools using computers in instruction to become active members of such organizations.

FIRST STEPS

1. *The program.* When a school decides to introduce the use of computers in instruction, the first step is *not* to purchase or lease hardware. A school should first determine what kind of program it wants and then select compatible hardware. Otherwise a school could make a financial commitment for hardware and find out later that more suitable equipment is available.

2. *The Hardware.* The experiences of other schools should not be overlooked. These schools can be helpful in the selection of hardware. At least they can indicate what has worked for them. Computer salesmen can make arrangements for visits to schools where their equipment is installed.

3. *Planning.* Where computer hardware is placed is important. It should be readily accessible at all times if the school is to get a full return on its investment. Schools purchasing computers should be sure there are adequate electrical sources. Computers run more trouble-free in areas where a constant temperature can be maintained. Computers do generate a certain amount of heat themselves.

Hardware should be delivered well in advance of the time the program is to start. It often takes a few weeks to work out the "bugs." Then there are telephone lines in the case of shared-time computer services. Installation again must be planned weeks, perhaps months, in advance if the program is to start on schedule.

LARGE COMPUTER SYSTEMS. Consortiums with many users need large computer systems like the IBM System/370 Model 165 pictured here. Photo courtesy IBM.

The Regional Consortium

Schools that are considering initiating a program of computer instruction would do well to investigate whether the services of a regional consortium are available to them.

A regional consortium is an organization, usually nonprofit and frequently associated with an educational unit, that supplies computer time-sharing services to member schools. In addition to supplying low cost computer services, the regional consortium can be an asset to a school embarking on a new program. The consortium usually has a staff of experienced personnel who are available for advice and guidance. Operating programs will be immediately available. Frequently the consortium will train the school's staff in the operation and use of the computer terminal and its application to instruction.

An added advantage are the User Groups that the consortium usually sponsors. At meetings of the user group or through the group's newsletter, the new school gets to know other member schools and to learn how they are using their terminals in instruction. Ideas are readily adapted since all member

schools use the same type of equipment, are serviced by the same computer, and use the same computer languages.

On the following pages are several examples of operating regional consortiums. The list does *not* intend to include all possible on-going projects. There is no complete directory of all projects since additional ones are constantly coming into existence. Projects not listed are requested to send pertinent information to NASSP's Committee on Educational Technology.

COLLEGE SPONSORED CONSORTIUMS

1. *Dartmouth College* (Hanover, N.H.). Dartmouth was responsible for introducing time-sharing instructional computer services to secondary schools in the New England states. Beginning as a federally funded experimental program in 1967, the project had as its goal the "Demonstration and Experimentation in Computer Training and Use in Secondary Schools." Eighteen high schools were originally involved in the program that later became the guide for other schools to follow.

One of the outstanding accomplishments made by Dartmouth was the demonstration that BASIC was an easily learned and effective computer programing language for high school students. BASIC is probably one of the most widely used programing languages in schools today. BASIC (*B*eginner's *A*ll-purpose *S*ymbolic *I*nstruction *C*ode), developed at Dartmouth under the direction of John G. Kemeny and Thomas E. Kurtz, is operational on many computer systems, including General Electric's 600 series, IBM's 360 system, Digital's PDP-8 and 10, Hewlett-Packard's 2000, Scientific Data Systems 940, and RCA's Spectra 70.

Dartmouth, in conjunction with the schools in their experimental project, developed many computer programs that other

schools will find very useful. Further discussion of these programs will be found later in this publication under *Software*.

2. *Project SOLO* (Pittsburgh, Pa.). "An Experiment in Regional Computing for Secondary School Systems" is the title of the experimental project supported in part by NSF funds and conducted by the University of Pittsburgh's Department of Computer Science in cooperation with the Pittsburgh Public School System. Project SOLO took its name from the Dual/Solo sequence used in flight instruction. The goal of the project is to take the student from dual mode (teacher/adult devised programs) to the solo mode (student created programs) in which the student writes programs for the computer, debugs, and executes them.

The University of Pittsburgh has developed an advanced version of BASIC called NEWBASIC/CATALYST, which enables a group of novices to be relatively sophisticated users of a time-sharing service tailored to their needs. Using this new computer language, a series of curriculum units called modules are being developed in mathematics, physics, chemistry, biology, social science, and computer science.

The Pitt Time-Sharing System (PTSS), which services Project SOLO as well as the University of Pittsburgh, has 50 terminals linked to an IBM 360/50 computer.

Thomas Dwyer is director of Project SOLO at the University of Pittsburgh, Pittsburgh, Pa. 15213.

3. *University of Rhode Island* (Kingston, R.I.). The University of Rhode Island has made it possible for five secondary schools in that state to obtain time-sharing computer services at low cost. An IBM 360/50 computer, located at the Computer Laboratory on the university's campus, serves the various divisions of the university in addition to the five secondary schools.

A graduate student in computer sciences at the university visits the secondary schools to provide assistance and guidance. The university periodically offers inservice training courses for secondary teachers. The university has also offered summer workshops for high school students. They are conducted by graduate students in computer science. A Computer Laboratory Newsletter is published for the information of users in the network.

William Hemmerle is director of the Computer Laboratory at the University of Rhode Island, Kingston, R.I. 02881.

AREA SCHOOL DISTRICTS SPONSORED CONSORTIUMS

1. *TIES* (St. Paul, Minn.). The Minnesota School Districts Data Processing Joint Board operates the computer co-op known as TIES (Total Information for Educational Systems). The consortium came into being to help Minnesota schools reduce the cost of computer services. They were able to bring costs of $10 to $12 per hour down to the cost of approximately $1.50 per hour. Initially the project was partially federally funded, but today it is self supporting.

TIES's million dollar computer center has two computer systems. A Hewlett-Packard 2000A time-shared system is used for instructional services. A Burroughs 3500 computer handles the administrative details of finance, student accounting, and business applications.

Formed in 1967 with the support of 20 school districts, TIES now provides 29 districts with instructional as well as administrative services. The TIES instructional system has 48 ports and will be expanded to 64 ports. This means that the system will

be able to accommodate 64 users simultaneously. Currently there are 130 teletypewriters and five card readers on-line in the system in elementary, junior high, and high schools.

The Joint Board that operates TIES consists of two representatives from each district. The Joint Board elects an eight member executive committee which is the policy-making group. They also employ an executive director who is the chief administrative officer. There are 30 other professionals who operate the computer center.

Thomas C. Campbell is director of the Joint Board, located at 1925 W. County Road B-2, St. Paul, Minn. 55113.

2. *Region IV Education Service Center* (Houston, Tex.). Region IV is a regional high school computer-communications network for schools in the Greater Houston area. At present 67 teletypewriters and 10 card reader-printer terminals are linked by phone to the Region's RCA Spectra 70/46 and 70/45 at the Center in downtown Houston. An additional 53 teletypewriters and 10 card reader-printers are planned for installation.

Eventually all 225 secondary schools in the Region's 56 school districts will be provided complete educational data processing capability. Students use the time-sharing terminals for problem solving in mathematics, physics, and chemistry, as well as to learn computer skills. Student training in computer operation and program preparation, offered in vocational-technical and computer science courses, is handled through the card reader-printers.

T.S. Hancock is executive director of the Region IV Education Service Center, Houston, Tex. 77002.

3. *Project LOCAL* (Westwood, Mass.). Project LOCAL was created in 1967 by five neighboring school districts in the vicinity of Boston. They felt that they could best develop their programs

of computer instruction on a cooperative basis. The towns of Westwood, Lexington, Natick, Needham, and Wellesley had to form their own private corporation to carry out their plan because of the restrictions of state law. The superintendents of the five towns serve as the project's Board of Directors.

Project LOCAL set up its own central office apart from the five school districts to serve all five equally. The Board hired a director, an assistant director, and clerical help. Although the program was originally funded by a federal grant, it is now self supporting.

Each of the five districts has a Digital PDP-8/I computer that can be operated in a time-shared mode. The computer is located in each district's high school, with terminals in some cases placed in elementary and junior high schools.

The Project LOCAL office handles the administrative aspects of the program. It is also responsible for ensuring the proper maintenance of hardware in each of the member schools. The director and his assistant also provide guidance and advice on technical matters involving computers and instruction, including suitable computer programs. The project office has assembled, and circulates periodically among the schools, a mini-library of 35 to 40 books, materials, and research papers dealing with computers, programs, and instruction. The office also arranges for inservice training courses for teachers.

Each of the five school systems has appointed a coordinator who meets at least monthly with the other coordinators and the project director to discuss problems and to share ideas and solutions.

Other surrounding high schools, impressed with the success of LOCAL, have asked to join the network. As a result, the project is now providing time-shared services to 15 school systems in the Boston metropolitan area.

Robert N. Haven is executive director of Project LOCAL, 44 School Street, Westwood, Mass. 02090.

4. *LIRICS* (Long Island, N.Y.). The Long Island Regional Instructional Computer System (LIRICS) was formed in the spring of 1971 by the Boards of Cooperative Educational Services (BOCES) of Nassau and Suffolk Counties on Long Island. The system was the out-growth of the Huntington (N.Y.) Computer Project and Suffolk County's BOCES III Instructional Computer Center. The purpose of the network was to provide low cost time-shared computer services to long Island schools.

LIRICS provides services to 42 elementary, junior high, and senior high schools in 35 school districts in Nassau and Suffolk Counties. Each school has at least one on-line and one off-line teletypewriter terminal. The terminals are linked to a Digital DEC 10 computer in the geographical center of the network at the Instructional Computer Center, located in the Wilson Technical High School in Dix Hills.

LIRICS is directed by a management team consisting of the assistant superintendents of the three BOCES areas: Nassau and Suffolk III and Suffolk II. The Instructional Computer Center has a director who is in charge of operations. The network provides inservice training workshops for member schools. It also provides them with an Operations Handbook as well as a Tape Library Index to programs that are available. The system operates chiefly on the BASIC language. COBOL (Common Business Oriented Language) is available on a scheduled basis.

Gerard Damm is director of LIRICS, Wilson Technical High School, 17 Westminster Avenue, Dix Hills, N.Y.. 11746.

5. *Eastern Kentucky Educational Development Corporation (EKEDC)* (Ashland, Ky.). EKEDC was formed in 1965 by 32

school districts in eastern Kentucky with the support of federal funds. The network is operated under the guidance of a board of directors elected from member school districts and has representatives from the Kentucky State Department of Education and Morehead State University. In charge of operations are a director, an assistant director, and a coordinator.

The present plan calls for EKEDC to provide both instructional and administrative services to its member schools. Eventually 64 teletypewriter terminals will be connected to the system's RCA Spectra 70/45 computer located in Ashland. EKEDC uses the Suppes-Jerman CAI drill and practice program in arithmetic.

Edwin Jones is director of EKEDC, 925 Winchester Avenue, Ashland, Ky. 41101.

SCHOOL SPONSORED CONSORTIUMS

1. *South Portland (Me.) High School.* This large senior high school, one of the original schools tied into Dartmouth's Kiewit Computation Center, found that it needed more terminals for the high interest that many of its students had developed for computers. The cost for additional terminals, however, would have been prohibitive.

Ann Waterhouse, who directs the computer project together with Principal Keith Thompson, initiated the idea of purchasing their own small time-shared computer. Through the partial help of a federal grant in the summer of 1970, they were able to purchase a Digital TSS/8I, which has provision for up to eight terminals. To reduce their future operating costs when the federal grant terminated, South Portland decided to sell time to neighboring high schools. They were deluged with requests.

They recommend their procedure to other high schools who are desirous of expanding their computer capability but want to keep their costs low. At the same time they are providing low cost computer services that would not otherwise be available to neighboring schools. But important to remember is that South Portland's staff had years of experience with computers before they embarked on the venture.

South Portland High School, 637 Highland Avenue, South Portland, Me. 04106.

2. *Wayne (N.J.) Consortium.* This regional consortium, operated by the Wayne Public Schools, was the idea of Henry Peterson, mathematics coordinator.

Eleven area schools are serviced by the Hewlett-Packard 2000B located in the Wayne Hills High School. The purpose of the project is to provide low cost computer services to the Wayne schools as well as to other area schools.

The system has the Suppes-Jerman CAI drill and practice programs in arithmetic as well as some of the simulation programs developed in the Huntington project.

Further information can be obtained from Henry Peterson at Wayne Hills High School, Wayne, N.J. 07470.

COMMERCIAL CONSORTIUMS

1. *Project PLAN* (Waltham, Mass.). Project PLAN was developed in 1967 through the cooperative efforts of the Westinghouse Learning Corporation, the American Institute for Research, and 13 school districts in California, Massachusetts, New York, Pennsylvania, and West Virginia.

Project PLAN (*P*rogram for *L*earning in *A*ccordance with *N*eeds) is an individualized system of instruction that uses the

computer to aid the teacher in the management of instruction. The computer maintains a profile of progress for each pupil based upon the tests that it scores. Thus it is a computer-managed program of instruction, with the computer used exclusively for this purpose.

Project PLAN provides the school with modules or learning units in the subject areas it desires. Modules are available in mathematics, language arts, science, and social studies on the elementary, junior high, and high school levels. These materials, however, are handled by the teacher and not by the computer, which is used only to manage the program.

Additional information can be obtained from the Westinghouse Learning Corporation, 235 Wyman, Waltham, Mass. 02154.

2. *Time Share Corporation* (Hanover, N.H.). A number of schools lease computer time from commercial time-sharing companies located in most large cities throughout the country. An example is the Time Share Corporation of Hanover, N.H. Time Share is a private corporation and should not be confused with Dartmouth College's Kiewit Computation Center in the same town.

Time Share Corporation services about 30 schools in the New England area and reaches as far south as New Jersey. Through its network of telephone lines and multiplexer equipment, Time Share has brought computer accessibility practically to the doors of secondary schools in New England. In many cases, except for those schools in remote areas, the school pays only a local call charge to reach Time Share's computer lines. Like other commercial companies, Time Share has various plans available for school time-sharing.

Information concerning its services can be obtained from Time Share Corporation, Hanover, N.H. 03755.

This review of regional consortiums was not intended to be all-inclusive, but rather to give a sampling of the services that are now available to schools. Contact your State Department of Education for information concerning regional computer consortiums. Commercial consortiums are usually listed in the yellow pages of the telephone directory.

MINI-COMPUTERS. Small computers like DEC's EduSystem 15 are available to schools at a price under $10,000.
Photo courtesy Digital Equipment Corp.

On-Going Instructional Computer Projects

Other examples of on-going computer projects include:

1. *Project INDICOM* (Pontiac, Mich.). INDICOM is a highly developed CAI (Computer Assisted Instruction) program operated by the Waterford Township Schools in Pontiac. The project has involved the services of some 40 teachers. Beginning in 1967, the project was introduced on the elementary school level. At that time, 32 instructional teletypewriter terminals located at the Riverside Elementary School in Waterford were linked to an RCA Spectra 70/45 computer system in Palo Alto, Calif. In 1969, with the installation of an RCA I-71 computer system at Waterford's Mott High School, 16 of the terminals were moved from Riverside to Mott, and a CAI program was initiated

on the secondary level. All 32 terminals are now connected to the new computer system. Audio and graphics components were added to the system in 1970.

The goal of INDICOM was to provide individualized tutorial programs using the computer as the tool of instruction. CAI programs have been prepared in mathematics, science, business, language arts, spelling, reading, social studies, economics, music, and library research skills.

Ronald Arnold is director of Project INDICOM, Waterford Township School District, 1325 Crescent Lake Road, Pontiac, Mich. 48054.

2. *Project REFLECT* (Kensington, Md.). REFLECT is another example of the development of continuing CAI programs. This project, sponsored by the Montgomery County Public Schools in Rockville, Md., was aided by federal and state grants.

The project schools (Albert Einstein High School, Newport Junior High School, and Pleasant View Elementary School) are located close to each other in the Kensington-Wheaton area of Montgomery County. The purpose of REFLECT was "to set up the facilities and a program for bridging the gap between technology and the school curriculum, to develop staff understanding, and to explore the effectiveness of the use of computer-assisted instruction within a large public school system."

REFLECT employs an IBM 1500 Instructional System that has an IBM 1131 as its central processing unit. There are 16 terminals in Albert Einstein High School and eight terminals in Pleasant View Elementary School. The terminals include both teletypewriters and CRT's (video display units). Students at Newport Junior High use the terminals at the high school since the schools are located on the same campus.

Among the CAI programs that have been developed are ones in arithmetic, geometry, language arts, general science,

chemistry, Algebra I and II, Advanced Algebra, Consumer Mathematics, and physics. Programs are in tutorial, drill and practice, problem solving and simulation modes.

William M. Richardson is director of REFLECT, located at Albert Einstein High School, 11135 Newport Mill Road, Kensington, Md. 20795.

3. *Project CATER* (Centereach, N.Y.). CATER, an experiment in Computer Managed Instruction (CMI), was sponsored by the Middle Country Central School District in Centereach, Long Island, N.Y., with a grant from Encyclopedia Britannica as well as with federal aid.

The project uses a Digital PDP-8/E computer located at Dawnwood Junior High School connected to two teletypewriter terminals at Dawnwood, two at Seldon Junior High School, and two at Centereach Senior High School.

CATER uses Britannica's TEMAC series in individualized instruction in mathematics. The computer scores the student's test at the end of each unit, records his score, keeps track of his progress, and assigns each student to a mathematics class section based upon his progress.

Richard Haskell is director of Project CATER, located at Dawnwood Junior High School, Centereach, Long Island, N.Y. 11720.

4. *Philadelphia (Pa.) School System.* A variety of programs are being conducted in the Philadelphia Public School System. Computer assisted instruction is operational in four schools in reading and biology. All of Philadelphia's 18 senior high schools offer courses in computer education. Computer concepts are also being taught in the city's 35 junior high schools.

The CAI program in biology has a Philco 102 computer system that is connected to eight CRT terminals at each of the following schools: Germantown High School, Overbrook High

School, Wanamaker Junior High School, Roosevelt Junior High School, and the computer center. The curriculum for the program was developed by Philadelphia's personnel.

The computer education courses at the senior and junior high schools are operated through a teletypewriter terminal at each of the schools. These terminals are linked to a Hewlett-Packard 2000B computer system at the computer center.

Philadelphia is also cooperating with the Pittsburgh School System in a project sponsored by Pennsylvania State University. The goal of the project is to develop CAI material for Algebra I and General Mathematics.

Sylvia Charp is director of Instructional Systems, Philadelphia School District, Philadelphia, Pa. 19104.

5. *Buffalo, N.Y.* The Hutchinson Central Technical High School in Buffalo has developed a comprehensive program in computer technology for technical high school students.

As a result of the program, these students have the opportunity to major in computer science. A well-equipped computer lab with an IBM 1130 computer, together with peripheral equipment, provides students with the practical opportunities for learning the new technology. Complete curriculum guides have been developed for the program.

Additional information can be obtained from Robert Santuci, Computer Science Department, Hutchinson Central Technical High School, 256 South Elmwood Avenue, Buffalo, N.Y. 14222.

6. *Half Hollow Hills* (Dix Hills, N.Y.). Well over a thousand children in grades three through 12 in the Half Hollow Hills School District, Dix Hills, Long Island, N.Y. are receiving instruction through a system of 16 teletypewriter terminals located in three elementary schools, three junior high schools, and a senior high school.

When the Huntington Computer Project terminated in June, 1970, the Half Hollow Hills District purchased one of its Digital TSS-8/I computers. A nucleus of teachers who received their training in the Huntington Computer Project taught other teachers the fundamentals of BASIC programing and computer operation in a series of summer workshops and school-year inservice training courses. Approximately 80 teachers have been trained in this way.

In the workshops, teachers developed the programs that are now being used in the schools. Drill and practice computer programs have been written for the elementary level in arithmetic, spelling, reading, social studies, and ecology. Computer concepts are being taught to junior high school students. Senior high school students are taught to write their own programs and to use the computer for problem solving. Courses are also available in BASIC and Fortran programing. An independent study course in programing has also been developed.

The senior high school staff is currently working on the development of a computer-managed instructional program for its individualized course in algebra.

Gerard Burke is director of Computer Instruction, Half Hollow Hills High School, 50 Vanderbilt Parkway, Dix Hills, N.Y. 11746.

7. *Project REACT* (Portland, Ore.). Developed by the Northwest Regional Educational Laboratory, REACT stands for *R*elevant *E*ducational *A*pplications of *C*omputer *T*echnology. Its purpose is to develop instructional units so that teachers and administrators can increase their basic understanding of computers and how they can be used in instruction and administration. Project REACT has developed 24 instructional units or "packages" organized into three courses, each providing 30 hours of instruction. Each course consists of from six to 10 booklets or units. For instance, Course III contains six booklets that

contain application units for business education, English, mathematics, science, and social studies. Any of the three courses can be used as the basis for an inservice course or they can be used for individual study. The booklets comprising the course can be purchased as a set or individually. REACT also offers on-line training in computers for interested school personnel.

REACT is continuing to develop two additional sets of materials. The first is a set of computer-oriented curriculum units in mathematics. Each unit is built around a "canned" computer program and contains materials for students and for teachers that provide an effective guide for the use of the computer program. The units provide a "computer dimension" for the study of mathematics but do not require a knowledge of programing techniques by the teachers or students. The second is a set of manuals for use at the secondary level to train students in computer related careers. For additional information, see the section on *Software for the Computer*.

8. *Brentwood Project* (Ravenswood, Calif.). The Institute for Mathematics Studies at Stanford University has been developing programs and conducting research in computer-assisted instruction since 1963. In 1964 Patrick Suppes, director of the Institute, initiated the Brentwood School Project at the Ravenswood City School District. This project was responsible for the development of CAI programs in spelling, mathematics, and reading for elementary school children. The Institute has also developed a CAI program for the study of Russian.

9. *Other Projects.* Since there is no complete source of ongoing projects, perhaps some successful projects have been overlooked. The author encourages project directors to send details of their operation to NASSP's Committee on Educational Technology.

Software for the Computer

One of the problems involved in initiating a program of instruction using computers is software. There are two types of software that computer instruction needs. The first includes programs that are fed into the computer to perform a particular operation, for instance a CAI program or a simulation program. The second type of software includes the texts that need to be placed in the hands of the student while he is learning computer operation, or a computer language like BASIC.

1. *The Kiewit Computation Center* at Dartmouth College has a series of publications and computer programs that schools will find useful. Write for their latest listing of publications. Some are free. Available ones include:

- BASIC in Ten Minutes a Day
- Some Suggestions for Student Programs
- Use of Computer in a General Math Course
- Junior High School Uses of a Time-Shared Computer
- Some Computer Applications in Secondary School
- Science
- Ninth Grade Word Problems

Write: Kiewit Computation Center, Dartmouth College, Hanover, N.H. 03755.

TIMESHARING — In timesharing the teletype can be right next to the computer as pictured or located thousands of miles away connected through telephone lines to the computer. Photo by J. Meehan.

2. *Huntington Computer Project.* This project prepared and compiled a three-volume set of computer programs useful in high schools. Subjects include biology, chemistry, mathematics, physics, economics, and teacher aides. For copies of these programs write:

Ludwig Braun, director of the Huntington Computer Project, Polytechnic Institute of Brooklyn, Graduate Center, Route 110, Farmingdale, N.Y. 11735.

3. *Hewlett-Packard.* H-P has announced a computer-assisted program in mathematics for grades 1 through 6, arranged for drill and practice. Available for use on the HP 2000 Time-Shared System, *Write Hewlett-Packard, 1501 Page Mill Road, Palo Alto, Calif. 94303.*

4. *GCMP.* The Greater Cleveland Mathematics Program has published two manuals that schools should find useful. They are:

- GCMP Computers in the Schools—A BASIC Primer
- GCMP Computers in the Schools—Elementary Functions with BASIC

Copies are available from the Educational Research Council of America, Rockefeller Building, Cleveland, Ohio 44113.

5. *CAMP Series.* This is a series of texts suitable for teaching the use of computers in mathematics. CAMP (Computer Assisted Mathematics Program) was originally a research project involving a team of mathematics teachers at the University of Minnesota High School in Minneapolis. The purpose of the

series is to instruct junior and senior high school students in using the computer in the solution of mathematical problems and the development of mathematical ideas. The texts in print include:

- Computer Assisted Mathematics Program—First Course
- Computer Assisted Mathematics Program—Second Course
- Computer Assisted Mathematics Program—Algebra
- Computer Assisted Mathematics Program—Geometry
- Computer Assisted Mathematics Program—Intermediate Mathematics

Each text has an accompanying Teacher's Commentary with answers. The CAMP First and Second Course relate to computer use in general. The remaining three texts relate to specific mathematics subjects. *The CAMP series is published by Scott, Foresman & Company, Glenview, Ill. 60025.*

6. *Programing in BASIC.* This is a simply written manual for learning how to program using BASIC. It is suitable for use in the junior high school. It could also be used as a self-instruction text.

The author is Mario V. Farina. It is published by Prentice-Hall Inc., Englewood Cliffs, N.J. 07632.

7. *Bibliography.* A very extensive bibliography on computers and their uses is found in the Computer Education Resource Catalog prepared by Donald C. Holznagel, coordinator of Instructional Materials.

Write: Computer Instruction NETWORK, 4924 River Road, N., Salem, Ore. 97303.

8. *Project REACT.* REACT has developed a series of 24 booklets that have been organized in three courses:

Course I: Computers in Education: A Survey. This course develops an understanding of: computer equip-

ment and operation, how to communicate with computers, use of computers in education, and impact of computers on society.

Course II: Computer Applications/Administrators. This course develops an understanding of: effective computer applications, the computer as a decision-making and planning tool, opportunities and problems presented by a computer, the state of the art.

Course III: Computer-Oriented Curriculum. This course develops an understanding of applications in social studies, English, business education, sciences, and mathematics.

REACT has also developed a "canned" computer program for adding a computer dimension to mathematics. They also have available a set of manuals to train students in computer related careers.

Write: Northwest Regional Educational Laboratory, 710 S. W. Second Avenue, Portland, Ore. 97204.

9. *My Computer Understands Me* (When I speak in BASIC).

This is a 60-page, paper-covered booklet geared to a student's introduction to computer programing in the BASIC language. Written in a fashion that will make learning the basics of programing easy for students, it can be used as a self-instruction text.

Published by DYMAX, P.O. Box 310, Menlo Park, Calif. 94025.

Following is an instructional guide that is being used in a Computer Mathematics course at Half Hollow Hills High School, Dix Hills, N.Y. It is provided as an example of how a formal course in computer technology can be presented.

Instructional Guide: Course Outline in Computer Mathematics

Course Description: Computer Mathematics is a one semester course involving the use of a digital computer. Problem solving is presented as an organized and logical step-by-step process in which the computer is used as an aid. The computer is applied to non-mathematical as well as mathematical problems.

Length of Course: 20 weeks
5 recitations per week

Prerequisite: Mathematics 9 (Elementary Algebra)

Philosophy & Objectives:

1. To teach machine computing as a mathematical tool in solving problems with tedious computations.
2. To teach computer programing as an independent discipline.
3. To arouse interest in the study of advanced topics in mathematics.
4. To encourage students to consider as a vocation the field of programing.

TOPIC I. Introduction

Aim: To give an appreciation of the computer as an important mathematical tool.

Content:

1. History of the computer
2. Analog and digital computers
3. The binary system of numeration
4. Organization of a computer system

TOPIC II. Flow Charts

Aim: To give the importance of advanced planning of logical procedures in the solution of a problem.

Content:

1. Exercise in calling a party on the telephone.
2. Exercise in finding the sum of the first 100 numbers.
3. Exercise in finding the Nth term of the Fibonacci sequence.
4. Exercise in finding the first 1000 primes.

TOPIC III. Derived Languages

Aim: To give an appreciation for the importance of derived languages and their role in programing.

Content:

1. Meaning of a derived language.
2. Advantages of a derived language.
3. Examples of derived languages.
4. Subroutines

TOPIC IV. BASIC — The Time Sharing Language

Aim: To solve problems using the BASIC language.

Content:

1. Introduction to BASIC
2. BASIC arithmetic statements
3. Exponential Notation
4. Built-in Functions
5. Conditional statement
6. Arrays and subscripts
7. Looping
8. Matrix Computation
9. Subroutines
10. Input Statement
11. Output
12. Edit Commands

Supplementary Procedures:

1. Students must keep a neat and complete notebook.
2. Much of the class time is occupied in writing programs.
3. Teletype machines are placed in the classroom where students gain a practical experience as well as a mental one.
4. Machines are made available for student use throughout the entire day.

Evaluation Procedure: Students are assigned a set of problems for which a program must be written and a solution obtained. Each of the programs and their solutions is discussed with the instructor and an evaluation is made based on content.

References:

Algorithms, Computation and Mathematics
School Mathematics Study Group
Computer Oriented Mathematics
National Council of Teachers of Mathematics
BASIC – Introduction to Computer Programing
Using the BASIC Language
The Free Press
Time Sharing Basic Language
General Electric
Introduction to Basic Computer Programing
Call-A-Computer

GLOSSARY

This glossary of terms used in computer technology includes terms most frequently used and ones of most interest to school administrators. Complete technical detail has been sacrificed for simplicity.

Acoustic Coupler — A device that permits a terminal in a time-sharing system to be connected to any telephone. At the other end of the line is a piece of equipment known as a data access set (DAA) that connects the telephone line to the computer. Thus, it is possible to dial into a computer, if so arranged, from any telephone. Illegal use is controlled by code words that are periodically changed.

Algorithm — The procedure used for solving a problem step by step.

APL — A Programing Language—A programing language directed toward problem solving. It was developed by IBM for use on its equipment.

Basic — **B**eginner's **A**ll-purpose **S**ymbolic **I**nstruction **C**ode—an easily learned programing language using simple English commands. It was developed by Dartmouth College to encourage use of the computer by students and teachers. It has been taught to even elementary school level children. BASIC can be learned in a very short time—just a few hours if studied intensely.

Batch Processing — Collecting and assembling input so that it can be run on the computer at one time. For instance, collecting key punched or mark sense cards prepared by students and running them at one time to save costs.

CAI — **C**omputer **A**ssisted **I**nstruction—using the computer as a tutor as in drill and practice exercises.

Card Reader — A device that inputs the information on a key punched or mark sense card or paper into the computer. Some card readers provide immediate output on the same card or paper, for instance, when they are used for test correction.

CMI — **C**omputer **M**anaged **I**nstruction—using the computer to assist the teacher in the management of instruction. This type of application makes use of the computer for test correction, maintaining profiles on the progress of individual students or classes. It has also been used to assign students to homogeneous groups based upon their progress in a particular subject during the course of the school year.

COBOL — **C**ommon **B**usiness **O**riented **L**anguage—a programing language that uses English commands. It was devised chiefly for business applications. One drawback is that it requires fairly extensive storage for operation in the computer.

Computer — An electronic device that stores and processes information. The chief components of a computer are the CPU (central processing unit) and the core memory.

Core Memory — The chief memory of a computer. Some computers have only core memory, others have additional or secondary storage units such as magnetic drums, magnetic discs, or magnetic tape. Magnetic tape units are the most economical.

CPU — **C**entral **P**rocessing **U**nit is the chief component of a computer that makes calculations and decisions.

CRT — **C**athode **R**ay **T**ube—a video screen (similar to a TV) that can display the output from or input to a computer. Input is usually through a keyboard. The input appears on the screen. Input through a CRT can also be by a "light pen." The light pen is touched to the video screen at a specific spot to indicate a particular answer to a question that appears on the CRT. Advantages of the CRT is that it is noiseless when compared to the teletypewriter. It is also useful in plotting. The disadvantage is that there is no paper copy that can be saved if needed.

Debug — To look for an error in a particular computer program in order to correct it.

Flowchart — A graphical means of representing a logical course of action or procedure for a particular operation or the solution of a problem. A flowchart is usually prepared as the first step in writing a computer program.

FORTRAN — **For**mula **Tran**slator—a moderately simple programing language that can be used by high school students. It is geared chiefly for science and mathematics uses.

Garbage in—Garbage out — An expression meaning that poor or incorrect input results in poor or incorrect output. In other words, the computer does exactly as it is instructed to do.

Hardware — The physical equipment that makes up the computer or its peripheral equipment; such as, the main frame, transformers, wires, instruments, teletypewriter terminals, card readers.

Input — To feed information into a computer or one of its components.

I/O — Input and/or output.

Input/Output Hardware — Equipment that feeds (inputs) information to the computer or receives (outputs) information from the computer. Examples include electric typewriters, tapes, card readers, printers, teletypewriters.

MODEM — **Mo**dulator-**Dem**odulator—an electronic device that adjusts computer or teletype signals so that the signals may be transmitted via telephone lines.

Multiplex — An electronic device that permits one line to transmit more than one message simultaneously. It helps to lower the cost of telephone transmission in time-sharing systems.

Off-line — A terminal or piece of hardware that does not have access to the computer. To save computer time costs, an off-line teletypewriter terminal can be used to prepare a program on a paper tape. Then the paper tape can be fed to the computer through an on-line terminal at a very fast rate of speed effecting a saving in computer on-line charges. This is an economical procedure when it is not necessary for the student to interact with the computer.

On-line — A terminal or piece of hardware that has direct access to the computer.

Output — Information from a computer or one of its components.

Peripheral Hardware — The equipment that supports a computer's operation, such as line printer, card reader, magnetic tape drive, etc.

Program — A series of steps that directs the computer to perform in a certain way. The steps are usually numbered in multiples or 5, 10 or 100, etc., to permit later entry of additional steps, if necessary, in between the multiples.

Programing Language — Software entered into the computer to allow the user to communicate with the computer in an easy or direct way. For instance the BASIC language is geared for student and teacher use, FORTRAN for advanced science and mathematics use, COBOL for business applications. See name of programing language for further specific information. All programing languages are not compatible with *all* computers.

Remote Access — A terminal located some distance from the computer.

Software — A set of instructions or routines that directs the computer to act or react in a certain way—as opposed to hardware. See hardware. Software is also loosely used to mean any printed material that supports computer operation.

Storage — The ability of a computer to store information for later use. See also CORE MEMORY.

Terminal — The input/output hardware in a computer system. It can be an electric typewriter, a teletypewriter, or a CRT.

Time-sharing — A computer system that provides service to multiple users simultaneously. Entry into the system is through a terminal that can be standing next to the computer or located thousands of miles away and connected by telephone line.

Unit Record Equipment — Hardware used in support of computers. Examples of unit record equipment include the key punch, verifier, interpreter, card sorter, reproducer, collator, and accounting machine.